National Electric Energy Testing, Research & Applications Center

NETRAC

A Research Center of the Georgia Institute of Technology

Swimming Pools

2008 National Electrical Code Changes

Article 680.26

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DEFINITIONS 2005 NEC – Article 100

- **Bonding (Bonded). The permanent joining of metallic parts to form an electrically conductive path that ensures electrical continuity and the capacity to conduct safely any current likely to be imposed.**

- **Grounded. Connected to earth or to some conducting body that serves in place of the earth.**

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- **1959 NEC – No mention of swimming pools.**
- **1962 NEC – Article 680 – Swimming Pools**
  - **680-7 Grounding.**
    - (a) All metallic conduit, piping systems, pool reinforcing steel, lighting fixtures, and the like, shall be bonded together and grounded to a common ground. The metal parts of ladders, diving boards, and their supports, shall be grounded.
  - **680-8 Methods of Grounding and Bonding**
    - (c) Non-electrical equipment required to be grounded to a common ground in accordance with Section 680-7 shall be grounded in accordance with Article 250.
    - Structural reinforcing steel may be used as a common bonding conductor for non-electrical parts where connections can be reliably made in accordance with the provisions of Article 250.

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- **1975 NEC – Renumbering of Sections – Bonding and Grounding are now clearly separate issues.**
  - **680-22 Bonding**

    (a) The following parts shall be bonded together:…

    (b) These parts shall be connected to a common bonding grid with a No. 8 solid, copper conductor and connection shall be made in accordance with Section 250-113. The common bonding grid may be any of the following.
    - (1) The structural reinforcing steel of a concrete pool where the reinforcing rods are bonded together by the usual steel tie wires or the equivalent; or,
    - (2) The wall of a welded metal pool; or,
    - (3) A solid, copper conductor not smaller than No. 8.
  - **680-24 Grounding**

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- **1984 NEC – A very significant change / clarification added a fine print note mentioning the purpose of bonding is to eliminate voltage gradients in the pool.**
  - **(FPN): It is not the intent of this subsection to require that the No. 8 or larger solid copper bonding conductor be extended or attached to any remote panelboard, service equipment or any electrode, but only that it be employed to eliminate voltage gradients in the pool area as prescribed.**
- **1987 through 1996 – Only minor changes.**
- **1999 NEC – Article 680-22. The FPN (not mandatory) added in 1984 becomes text of the code under 680-22 Bonding.**

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- **1999 NEC – Article 680-22.**
  - **The NEC Handbook had the following comment: The primary purpose of bonding is to ensure that voltage gradients in the pool area are eliminated.**
  - **The revised wording of Section 680.22 in the 1999 Code makes it clear that the No. 8 conductor is only for the *elimination of the voltage gradient in the pool area* and is not required to provide a path for fault current that may occur as a result of electrical equipment failure.**
- **2002 NEC – Sect. 680.22 was changed to 680.26. Elimination of voltage gradients was made even stronger.**

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- **2005 NEC renamed Article 680.26 Equipotential Bonding**
  - **Added part (C) Equipotential Bonding Grid to 680.26.**
  - **The equipotential common bonding grid shall extend under paved walking surfaces for 1 m (3 ft) horizontally beyond the inside walls of the pool and shall be permitted to be any of the following:**

    (1) Structural Reinforcing Steel. The structural reinforcing steel of a concrete pool where the reinforcing rods are bonded together by the usual steel tie wires or the equivalent.

    (2) Bolted or Welded Metal Pools. The wall of a bolted or welded metal pool.

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- **2005 NEC – Part (C) Equipotential Bonding Grid to 680.26 (Continued)**

  (3) Alternate Means. This system shall be permitted to be constructed as specified in (a) through (c):

  - a. Materials and Connections. The grid shall be constructed of minimum 8 AWG bare solid copper conductors.
  - b. Grid Structure. The equipotential bonding grid shall cover the contour of the pool and the pool deck extending 1 m (3 ft) horizontally from the inside walls of the pool. The equipotential bonding grid shall be arranged in a 300 mm (12 in.) by 300 mm (12 in.) network of conductors in a uniformly spaced perpendicular grid pattern with tolerance of 100 mm (4 in.).
  - c. Securing. The below-grade grid shall be secured within or under the pool and deck media.

  - **Note: See Temporary Interim Agreement 05-2 for revisions to this section (exception to the bottom or sides of a nonconductive pool).**

PROBLEM

- 2005 NEC Article 680.26 covers bonding of metal parts in and around swimming pools to an equipotential bonding grid.
- The article assumes that one or more of the parts are in contact with the pool water.
- Some pools do not have any bonded metal parts.
- Water- deck voltages may be significant for such a pool.

PROBLEM & SOLUTION

ACTUAL CASE

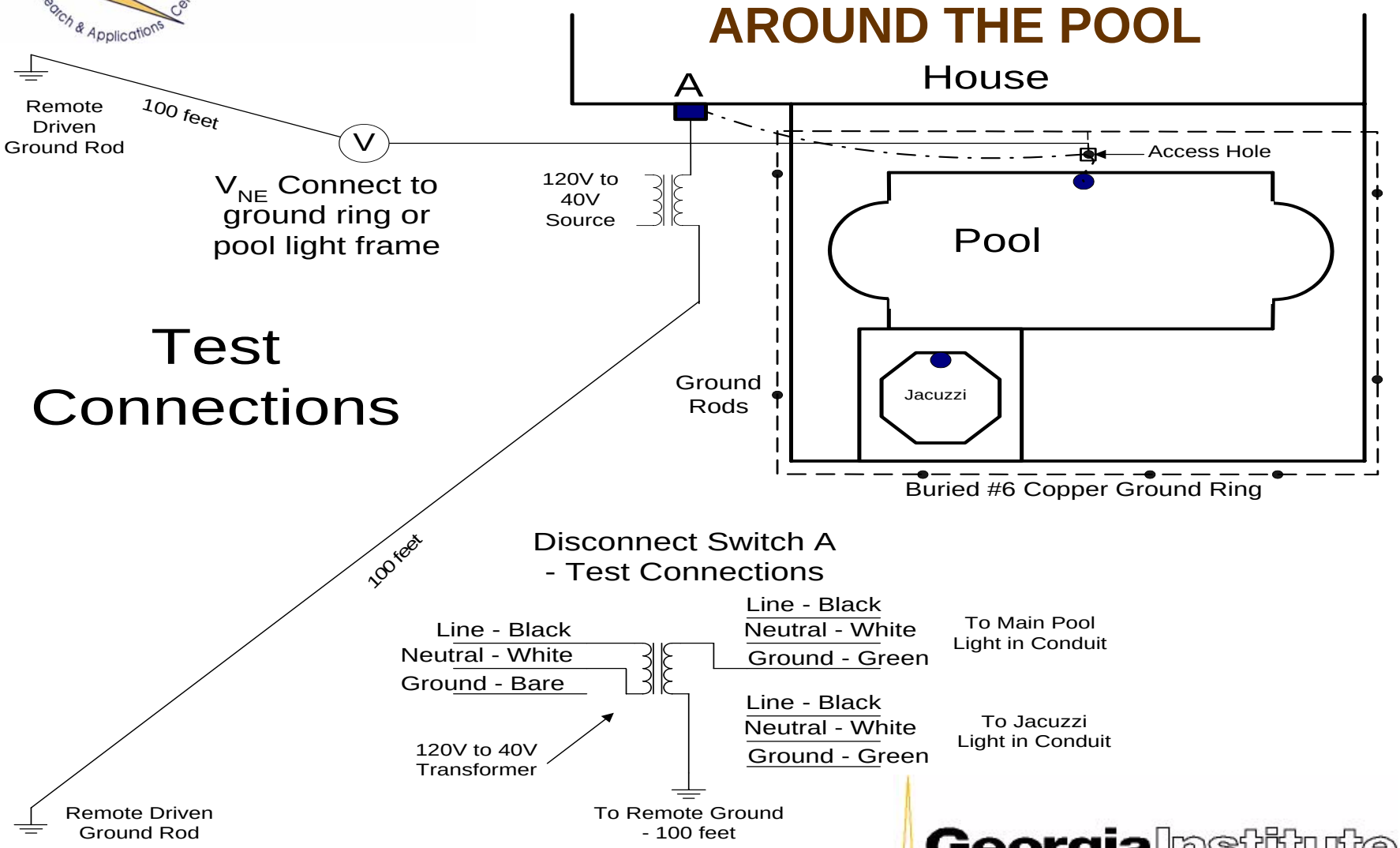
- An employee of a member company installed a one piece drop-in pool.
- An equipotential ground grid was installed around the pool as per NEC 2005.
- 1.7 to 2 volts was measured between the pool water and ground ring.
- A copper butt plate connected to a #8 copper wire was dropped in the water (see Figure).
- Upon bonding the copper butt plate in the water with the ground grid, the voltage differential went to zero.

APPROACH

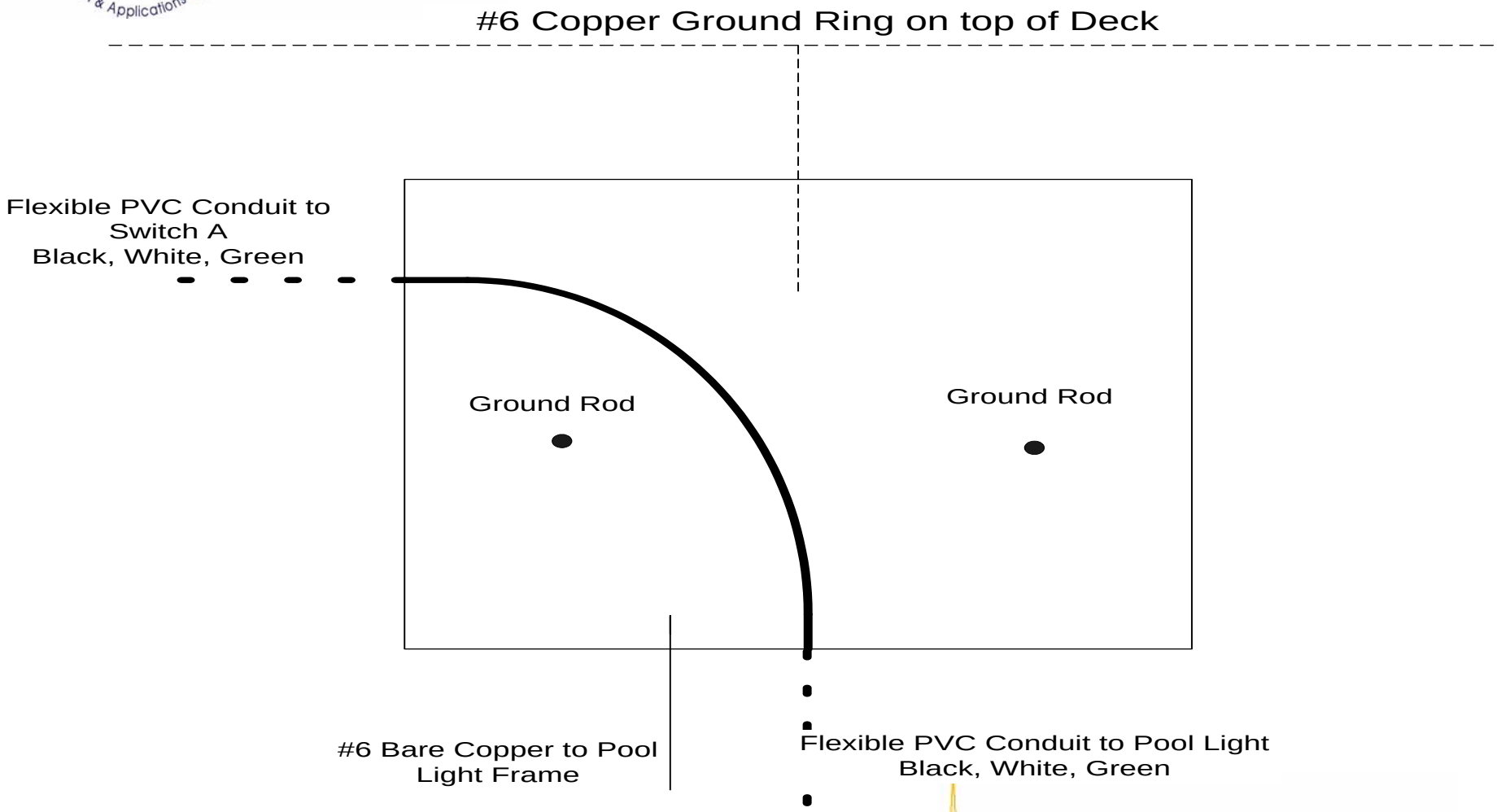
- **NEETRAC and a member company designed a field project to measure water-deck voltages at an existing swimming pool with a history of customer complaints.**
- **The project mitigated the customer's problem and allowed NEETRAC to measure water-deck voltages for various bonding scenarios in support of Article 680.26 and the proposed solution.**


POOL DESCRIPTION
Jacuzzi with an underwater light
Hole in the deck to connect or disconnect the light from the ground
Underwater light
Ground ring lying on the concrete
AWG #6 solid copper ground ring with seven ground rods driven at angle
120-volt electrical box serving the underwater lights
Wetland

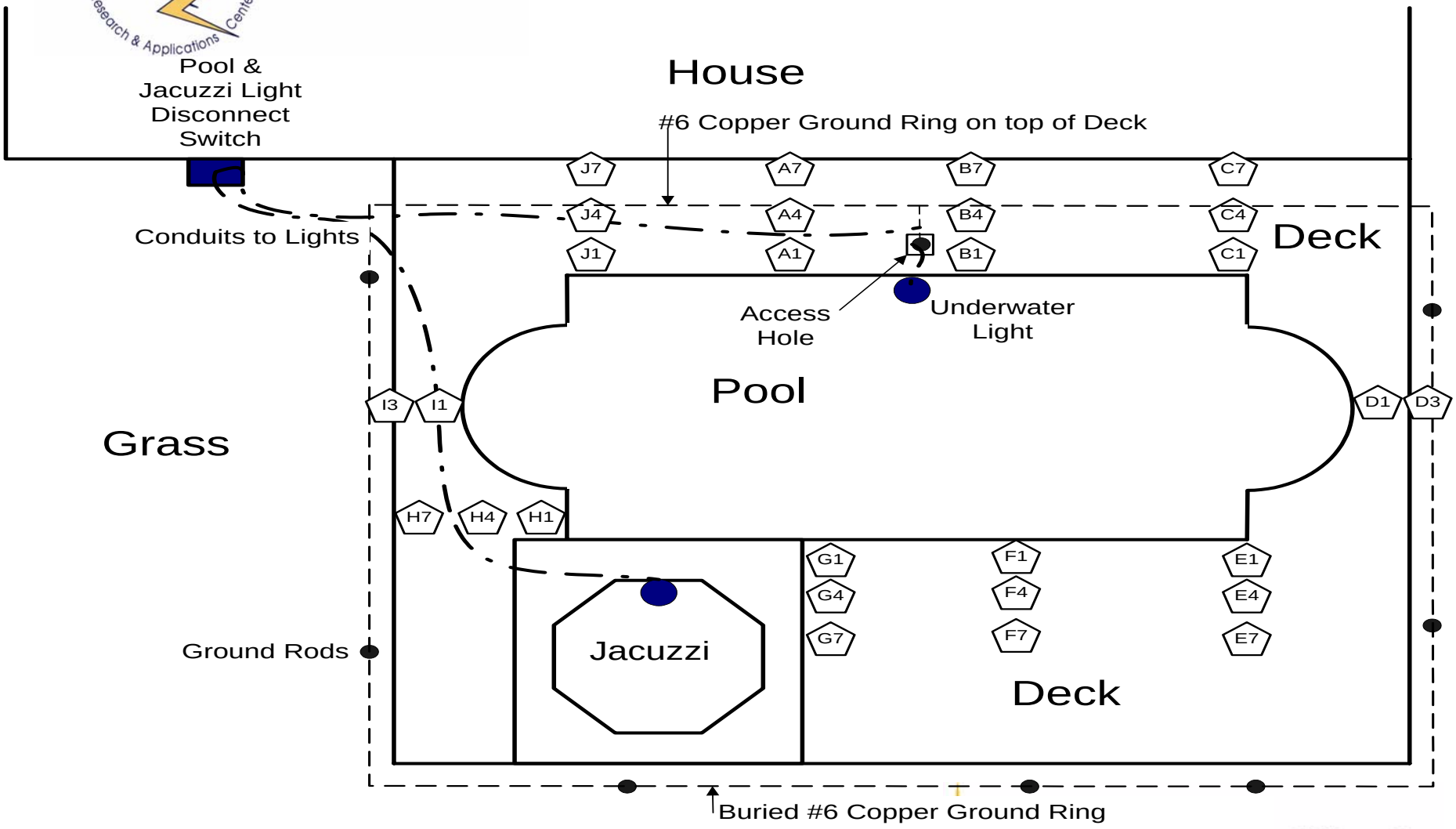
CUSTOMIZED TEST SETUP TO RAISE VOLTAGE GRADIENTS AROUND THE POOL



ACCESS HOLE IN DECK



WATER-DECK MEASUREMENT LOCATIONS AROUND THE POOL



THREE BONDING SCENARIOS PERTAINING TO ARTICLE 680.26 AND THE PROPOSED SOLUTION

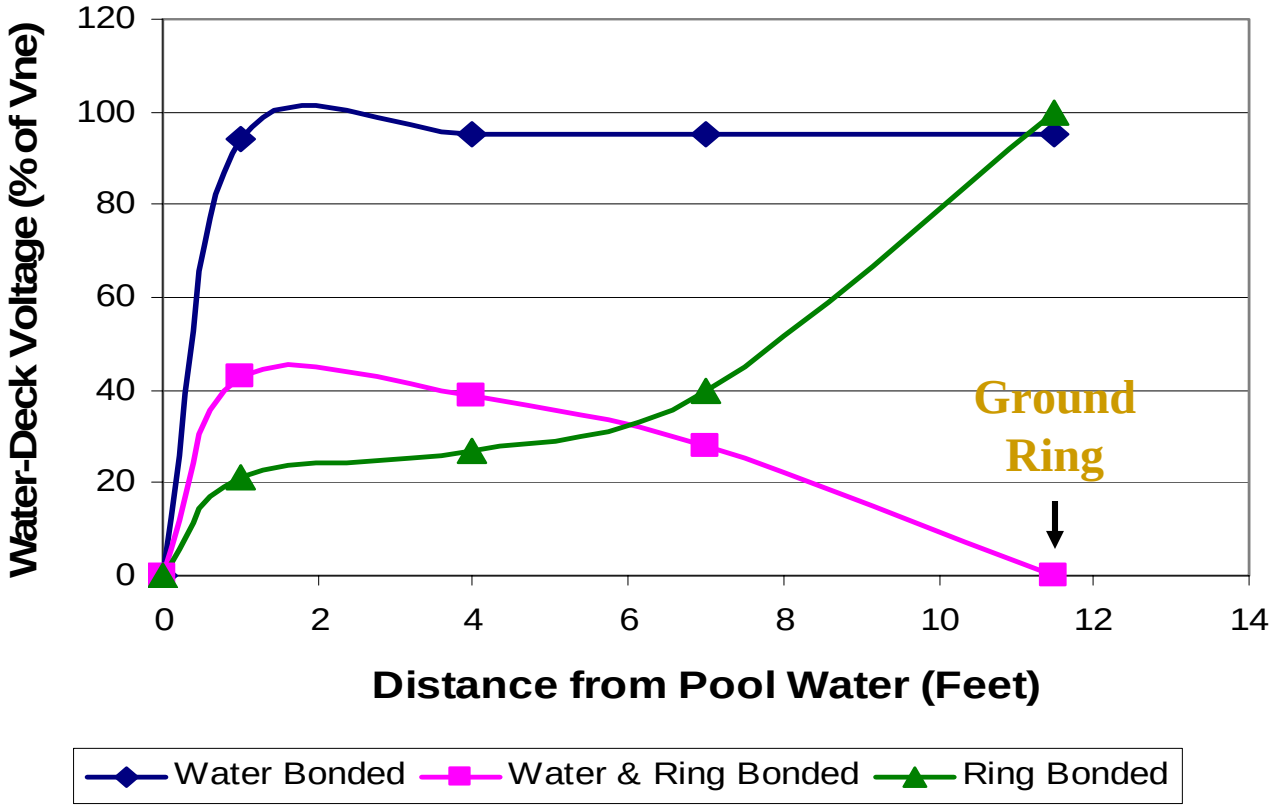
1. Pool light and water are bonded. Ground ring and rods are not bonded.

2. Pool light, water, ground ring and rods are bonded. (2005 NEC 680.26 requirement)

3. Pool and water are not bonded but ground ring and rods are bonded. (Problem with Article 680.26 when there is no metallic bond to the pool water.)

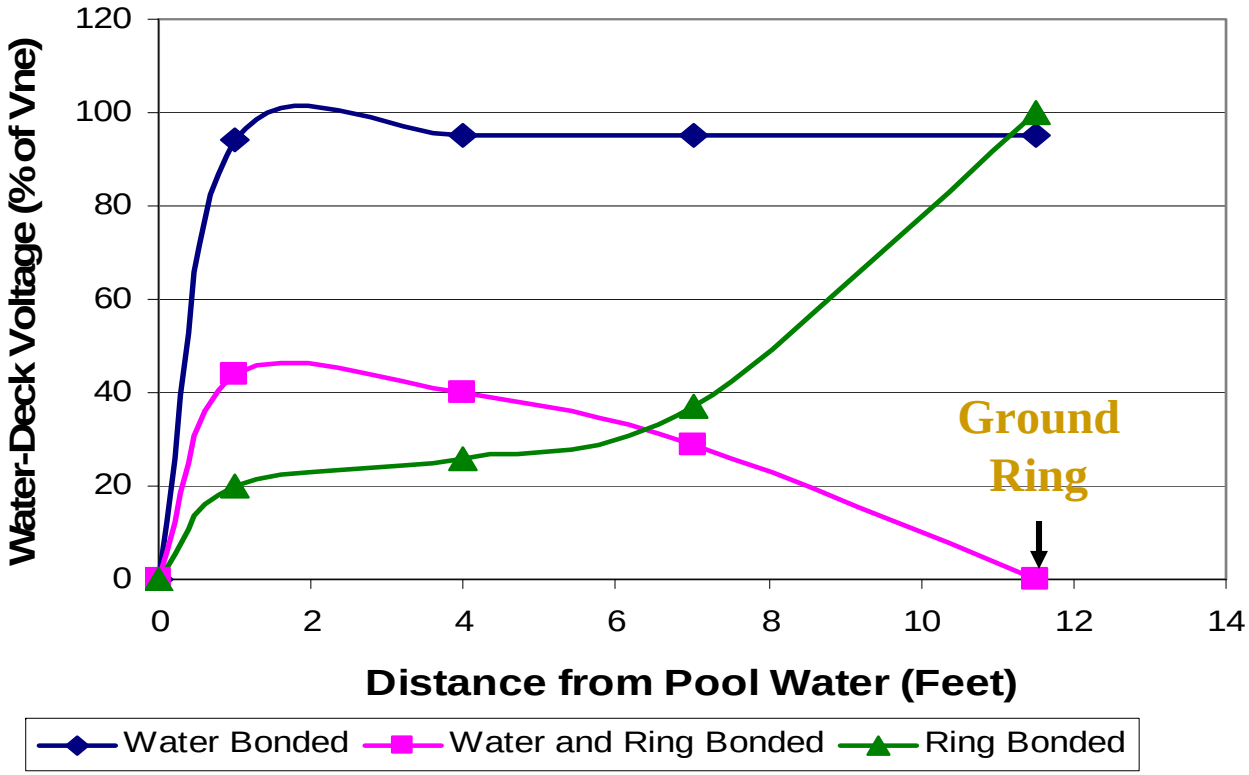
TEST DATA

Water-Deck Voltages along Location E



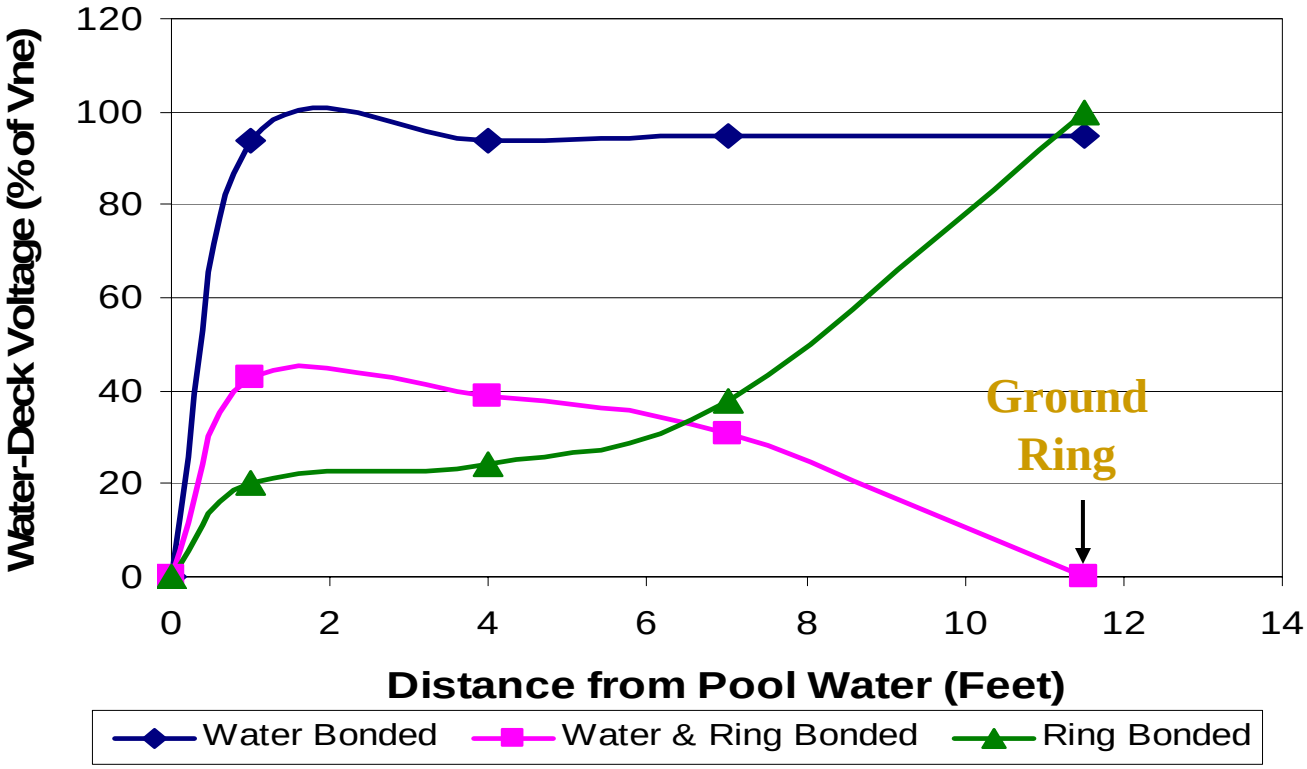
TEST DATA

Water-Deck Voltages along Location F



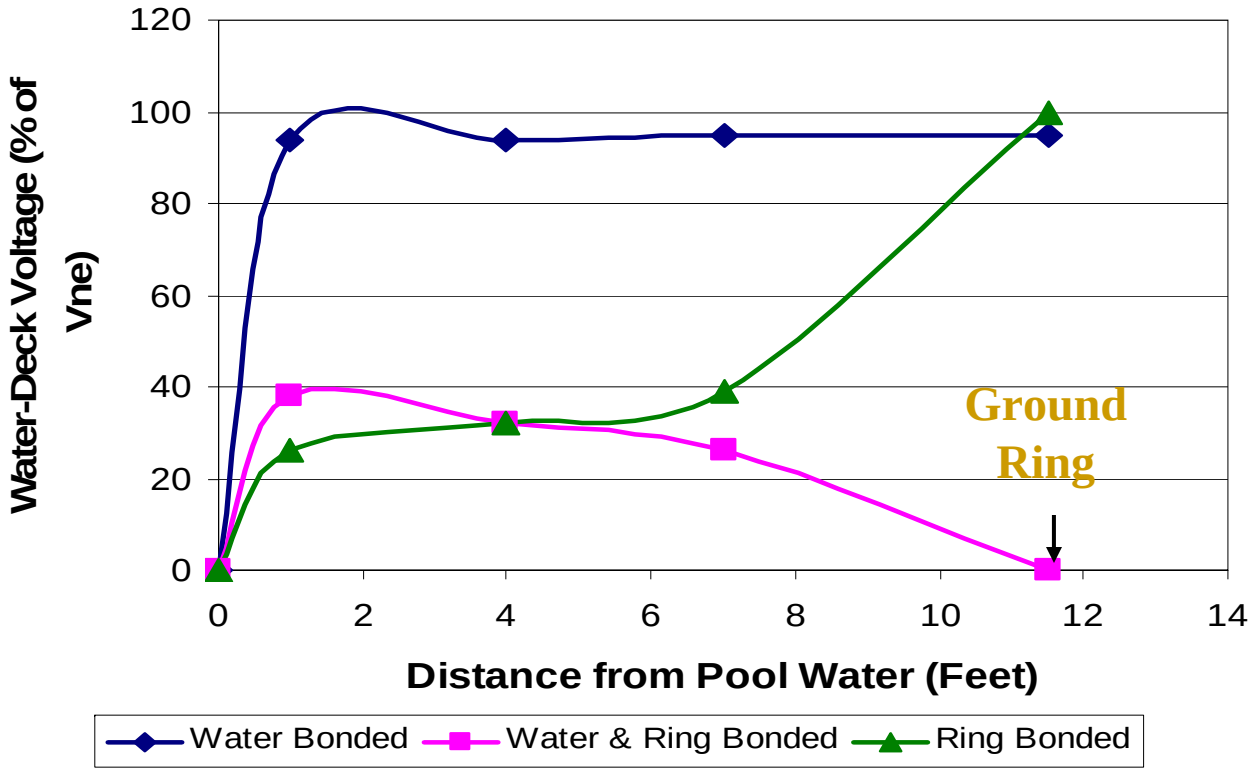
TEST DATA

Water-Deck Voltages along Location G



TEST DATA

Water-Deck Voltages along Location H



ANALYSIS

- **Blue graph (only pool water bonded)**
  - **Water – deck voltage rises almost 100% within one foot distance due to an insulated pool lining.**
  - **From one foot distance onward, the voltage practically remains the same.**
  - **As expected the maximum voltage gradient occurred across the insulated liner of the pool.**

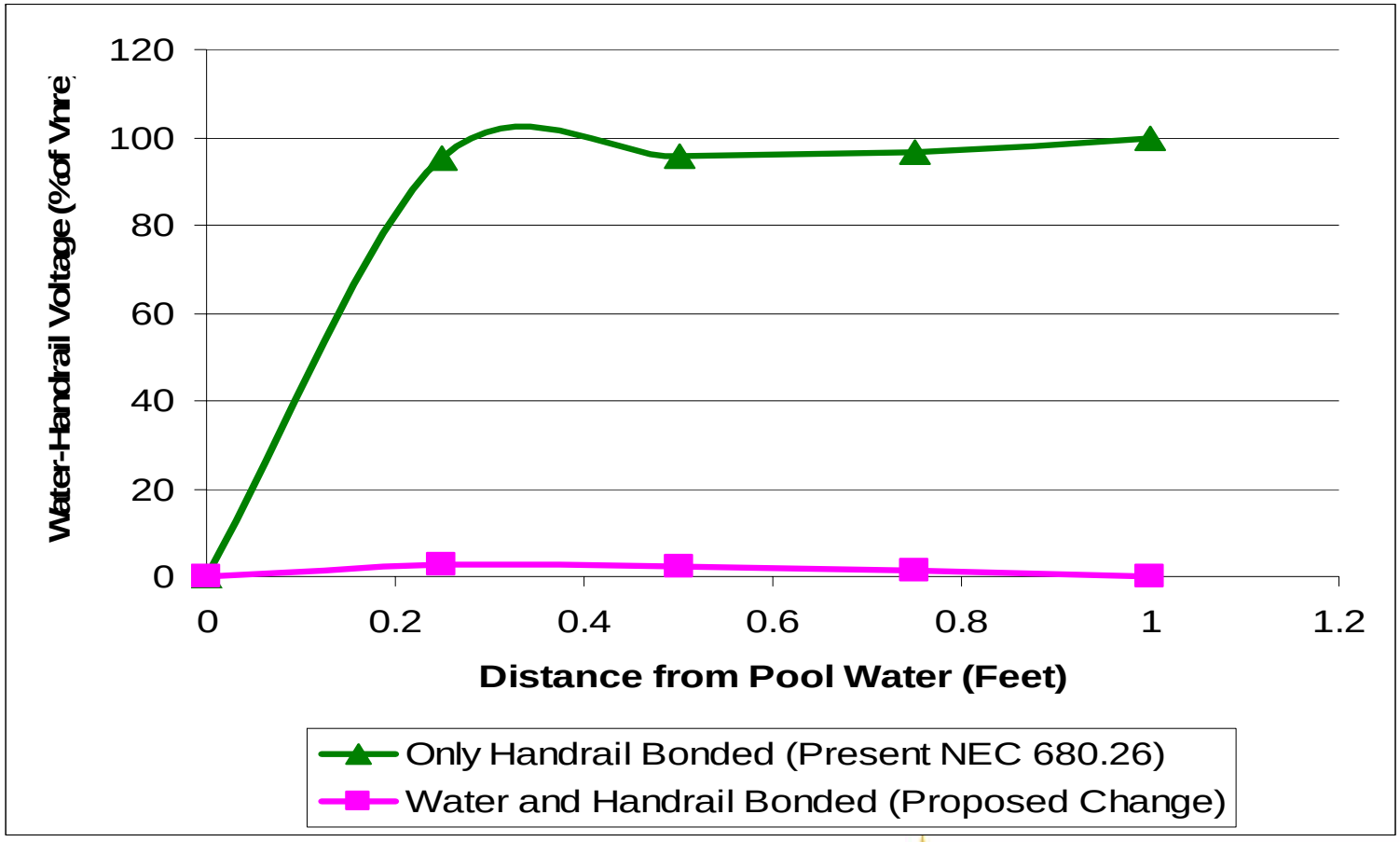
ANALYSIS (Continued)

- **Red graph (pool water and ground ring bonded)**
  - **The proposed change to Article 680.26 requiring intentional bonding of pool water.**
  - **The equipotential bonding of the water to the ground ring reduced the water - deck voltage from 95% (Blue Graph) to 40% near the water.**

ANALYSIS (Continued)

- Green graph (only ring bonded)
  - Present requirement of NEC Article 680.26.
  - Water-deck voltages increase to almost 100% as they approach the ground ring.
  - Since the ground ring is located at a distance of 11.5’ from the water, the voltage gradients near the water are not significant in this investigation.
  - Voltages near the water will increase significantly if the ground ring or a hand rail were to be located near the water.

PROJECTED WATER-HANDRAIL VOLTAGES BASED ON MEASURED DATA



NEC 680.26 PROPOSED CHANGE

ACCEPTED BY CODE PANEL 17 FOR INCLUSION IN 2008 NEC CODE

Insert a new Section 680.26(C) as follows:
680.26 (C) Pool Water

An intentional bond of a minimum conductive surface area of 5806 mm^2 (9 in^2) shall be installed in contact with the pool water. This bond shall be permitted to consist of parts that are required to be bonded in 680.26(B).

Renumber the present Sections sequentially from (C) to (D), (D) to (E), and (E) to (F).